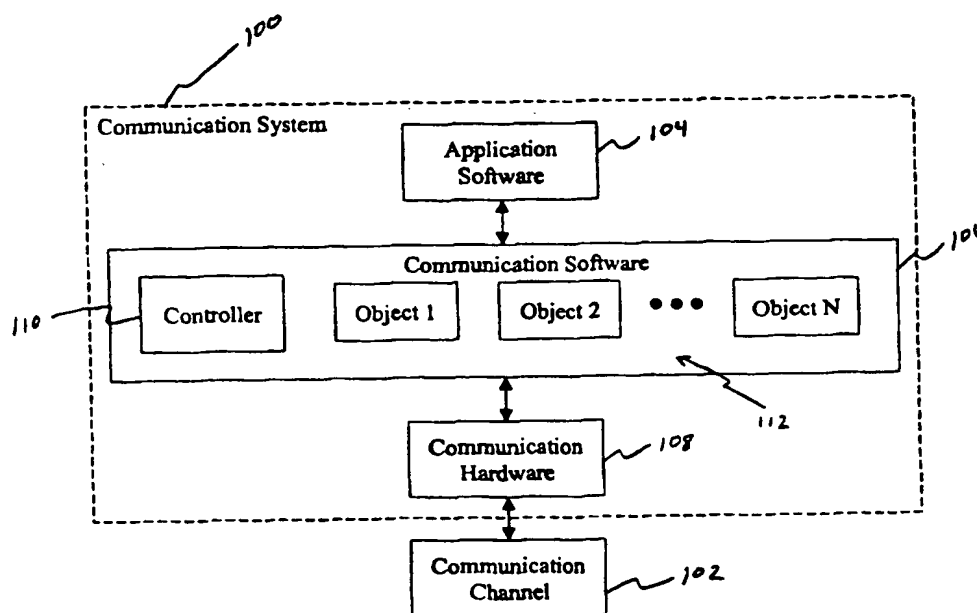




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H04L 29/06, H04M 11/06, G06F 9/445		A1	(11) International Publication Number: WO 00/16534
(21) International Application Number: PCT/US99/21660		(43) International Publication Date: 23 March 2000 (23.03.00)	
(22) International Filing Date: 17 September 1999 (17.09.99)		(81) Designated States: CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(30) Priority Data: 09/154,643 17 September 1998 (17.09.98) US 09/193,066 16 November 1998 (16.11.98) US		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
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(54) Title: MULTI-TASK PLUG-IN ARCHITECTURE FOR SOFTWARE MODEM



(57) Abstract

A multi-task structure for a software modem including a plurality of self-contained executable entities. The executable entities include at least a controller and a data pump with the controller operating as an interface between an operating system driver and the data pump when signals are passed from the operating system driver to the data pump. In addition, the data pump includes at least a scheduler and a hardware driver, the scheduler interacting with additional self-contained executable entities and enabling the data pump to operate using one or more individual ones of the additional self-contained executable entities according to the signals passed from the controller to the data pump.

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INTERNATIONAL APPLICATION UNDER
THE PATENT COOPERATION TREATY
(Attorney Docket No. 98RSS214PCT)

MULTI-TASK PLUG-IN ARCHITECTURE FOR SOFTWARE MODEM

Zeev COLLIN, Tal TAMIR

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority pursuant to 35 U.S.C. § 120 to U.S. Non-provisional Patent Application Serial No. 09/154,643, filed September 17, 1998, pending, which is hereby incorporated herein by reference in its entirety, and U.S. Non-provisional Patent Application Serial No. 09/193,066, filed November 16, 1998, pending, which is hereby incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to software modems, and more particularly to a software modem having a data pump with a plurality of self contained executable modules for updating and adding drivers to the software modem.

2. Description of the Related Art

Conventional modems accept digital data supplied by a computer system and convert it into modulated analog waves that are transmitted over a communication channel such as an analog telephone line. Modems also accept modulated analog waves via the communication channel and convert them into a digital form to pass on to the computer system.

5 Conventional modems using a telephone line communication channel send data at speeds commonly measured in bits per second, or bps. The most common modem speeds are 28,800 bps, 33,600 bps, and 56,000 bps. However, the actual speed of data moving across a telephone line varies and does not always equal the speed that the modem is capable of providing because the telephone line may operate with interference. Thus, to assure data
10 integrity, data often travels across a telephone line communication channel at a lower speed than is available from the modem.

 Modems have been classified according to various parameters such as potential modem speed, data compression techniques, and other communication protocols. Common classifications include V.34, for 33.6 kbps modems and V.90, for the 56 kbps modem standard.

15 A typical hardware modem operating on a general purpose computer includes a controller, a digital signal processor (DSP), a codec (compressor/decompressor), and a digital access arrangement (DAA). External hardware modems typically include a universal asynchronous receiver-transmitter (UART) while internal hardware modems replace the UART with a hardware driver.

20 As processing power in general purpose computers has increased through development of higher powered microprocessors, modem designers have realized that the computer's processor can be used to handle some modem operations. Thus, some functionality performed by conventional hardware modems has begun to be implemented in software. As time goes on, more and more functionality of hardware modems is being realized in software. However,
25 each time that new functionality is converted to software, the new software functionality is added to a single software object. Thus, if one part of the functionality is found to be operating improperly, the whole software object must be replaced.

The DSP of a software modem, by nature, performs many different signal processing tasks; e.g., data modulations, fax modulations, etc. In addition, the data pump performs general telephony tasks such as pulse or tone dialing. These tasks are implemented in a single software object and, in operation, consume a large amount of a computer's memory. Further, if the software modem is to be updated or changed, the whole object must be replaced. A hardware change in one area of the modem also requires total object replacement even though only a small portion of the object is affected.

SUMMARY OF THE INVENTION

Various aspects of the present invention can be found in a communication system comprising application software, communication software that interacts with the application software, and communication hardware that interacts with the communication software. The communication software includes at least one controller and a plurality of objects with the communication software operating as an interface between the application software and the communication hardware. Thus, the application software communicates with the communication hardware. The controller enables the application software to activate one or more individual ones of the plurality of objects to provide communication between the communication system and a communication channel.

The objects of the communication system often comprise driver modules having individual modem functionality. The at least one controller of the communication system enables the communication software to operate using a single one of the plurality of objects during operation of the communication system. The plurality of objects are individually modifiable and individually replaceable without regard to other ones of the plurality of objects and the plurality of objects are often selected from the group consisting of drivers, data link libraries, and threads.

Various other aspects of the present invention are realized in a method for operating a software modem on a computer system having a memory. The method comprises creating a plurality of software modules that interact with one another to perform software modem tasks on the computer system, scheduling the plurality of software modem tasks according to specific operations of the software modem, loading individual software modules into the memory of the computer system on an as needed basis as the software modem operates on the

computer system, and unloading individual software modules from the memory of the computer system when the individual software module is no longer required for operation of the software modem on the computer system.

The method may also comprise modifying individual software modules from the plurality of software modules with the modifications occurring independently of software modules in the plurality of software modules that remain unmodified. Modifying individual software modules may comprise debugging, upgrading, or isolating the individual software modules, in some cases, to perform diagnostics on the software modem independent of the remaining software modules of the software modem.

Further, a software modem according to principles of the present invention may include communication software and a modem card. The communication software often includes a controller and a plurality of modules, the plurality of modules being independent from one another and operating according to instructions received from the controller such that only modules specified by the instructions are executed in the software modem. The modem card often includes another controller, additional modules, and communication hardware. The another controller controls which of the additional modules to activate for interaction with the communication hardware.

The plurality of modules of the software modem are often modifiable independently of one another and the controller. In fact, modules may be added to the plurality of modules already existing in the communication software of the software modem. In addition, the additional modules of the modem card are modifiable independently from one another and the controller of the modem card. Similar to the modules of the communication software, the

5 modules of the modem card may be added to the additional modules already existing in the modem card of the software modem.

Other aspects of the present invention can be found in a software modem including a plurality of self-contained executable entities. The executable entities include at least a controller and a data pump with the controller operating as an interface between an operating
10 system driver and the data pump when signals are passed from the operating system driver to the data pump. The data pump includes at least a scheduler and a hardware driver, the scheduler interacting with additional self-contained executable entities and enabling the data pump to operate using one or more individual ones of the additional self-contained executable entities according to the signals passed from the controller to the data pump.

15 The self-contained executable entities of the software modem according to the present invention often comprise driver modules having individual modem functionality. The scheduler enables the data pump to operate using a single one of the additional self-contained executable entities during operation of the software modem. The additional self-contained executable entities are individually modifiable and individually replaceable without regard to
20 other ones of the additional self-contained executable entities. The additional self-contained executable entities are commonly selected from the group consisting of drivers, data link logic, and threads.

Still other aspects of the present invention can be found in a software modem that includes a controller and a data pump. The data pump may include an abstraction layer, a
25 scheduler, a sampler, a hardware driver, and a plurality of modules. The plurality of modules are independent from one another and operate according to instructions received from the scheduler such that only modules specified by the instructions are executed in the software

5 modem. Advantageously, the modules of the software modem are modifiable independently of one another and the controller. The modifiable modules comprise modules which enable adding additional modules to the plurality of modules already existing in the data pump of the software modem.

10 Other aspects of the present invention will become apparent with further reference to the drawings and specification.

15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995

1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995

2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995

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BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained when the following detailed description of the preferred embodiment is considered in conjunction with the following drawings.

Figure 1 is a block diagram of an exemplary communication system built in accordance with the principles of the present invention wherein, as illustrated, the communication system communicates with a communication channel via application software, communication software, and communication hardware.

Figure 2 is a block diagram of the communication system of Figure 1 wherein the communication hardware of Figure 1 is illustrated as being part of a modem card.

Figure 3 is a block diagram of portions of the communication system of Figure 1 wherein the application software and communication hardware are illustrated having multiple components.

Figure 4 is a block diagram of an exemplary computer system built in accordance with the principles of the present invention wherein the computer system is illustrated interacting with a telephone line via components such as a software modem.

Figure 5 is a block diagram of the software modem of Figure 4 illustrated in greater detail than in Figure 4.

Figure 6 is a block diagram of exemplary self-contained signal processing tasks or driver modules that operate in conjunction with the software modem of Figure 4.

5

DETAILED DESCRIPTION OF DRAWINGS

Figure 1 is a block diagram of an exemplary communication system 100 built in accordance with the principles of the present invention wherein, as illustrated, the communication system 100 communicates with a communication channel 102 via application software 104, communication software 106, and communication hardware 108. In one embodiment, a user controls the application software 104 in order to operate the communication system 100. The application software 104 interacts with the communication software 106 and prompts a controller 110 to determine which object(s) 112 to activate in order to operate the communication hardware 108 and carry out communications through the communication channel 102.

15

The object(s) 112 are interchangeable, modifiable, updateable, upgradeable, and may increase in number or in size. In one embodiment, one object 112 can interact with the application software 104 and activate other objects 112 to provide interaction with the communication hardware 108. Another embodiment provides multiple objects 112 to interact with the application software 104 and, together, activate a single object 112 for interaction with the communication hardware 108. Yet another embodiment provides for multiple objects 112 to interact with the application software 104 and then, in turn, to interact with multiple object 112 for interaction with the communication hardware 108. Advantageously, individual object(s) 112 can be modified without interfering with other object(s) 112. The

20

object(s) 112 also enable the communication system 100 to operate using only the required object(s) 112 for the requested function in the communication system 100. Further, only the required object(s) 112 are activated or accessed depending on requirements from the communication hardware 108. Thus, the communication system 100 enables multi-task plug-in objects and operates more efficiently than prior art communication systems.

Figure 2 is a block diagram of the communication system 100 of Figure 1 wherein the communication hardware 108 is illustrated as being part of a modem card 200. The modem card 200 includes the communication hardware 108 and a controller 202 that controls object(s) 204 and activates specific ones of the object(s) 204 on the modem card 200 according to desired operations of the communications system 100. Like the communication system 100 of Figure 1, object(s) 204 interact either directly or indirectly with the communication hardware 108 as instructed by the controller 202. Communication software 205 having a controller 206 is illustrated for controlling object(s) 208 as they interact with application software 210 and the modem card 200. The objects 204 and 208 interact as directed by the controllers 202 and 206, respectively, and create the interface between the communication software 205 and the modem card 200.

Figure 3 is a block diagram of portions of the communication system of Figure 1 wherein the application software 104 and communication hardware 108 are illustrated as having multiple components. Specifically, in this embodiment, the application software 104 comprises a plurality of software applications 300 for user access to the communication software 106. Particular software applications 300 direct the communication software 106 in particular manners. For example, the controller 110 is directed to activate one of the objects 112 which in turn activates another of the objects 112 which in turn interacts with a portion 302 of the communication hardware 108. The portion 302 of the communication hardware 108 then interacts with another portion 302 which in turn interacts with the communication channel 102. Of course, other variations and combinations of the process of the application software 104 interacting with the communication channel 102 are possible and the above example is offered only for illustrative purposes.

5 Figure 4 is a block diagram of an exemplary computer system 400 built in accordance with the principles of the present invention wherein the computer system 400 is illustrated interacting with a telephone line 402 via components such as a software modem 404. An application 406 accesses the software modem 404 through an operating system communication driver 408 and the software modem 404 accesses the telephone line 402 through a hardware interface 410. The application 406 is a standard modem application for a user to operate a modem on the computer system 400. The operating system communication driver 408 is a standard communication driver. The hardware interface 410 typically comprises a codec and a DAA and provides a path for the software modem 404 to communicate with the telephone line 402.

15 Figure 5 is a block diagram of the software modem 404 illustrated in greater detail than in Figure 4. The software modem 404 is illustrated having a plurality of modules including a port driver 500, a controller 502, a data pump abstraction layer (DPAL) 504, an advanced modem operation scheduler (AMOS) 506, a sampler 508, and a hardware driver 510. Further, the software modem 404 includes a plurality of driver modules 512 that interact with the other modules in the software modem 404. Collectively, the modules between the controller 502 and the hardware interface 510 are often referred to as the "data pump" of the software modem 404.

Of particular note, the plurality of modules of the software modem 404 have been divided into individual tasks rather than being combined into a single object as in the related art. Specifically, in one embodiment, the data pump implements the scheduler (AMOS) 506 to select only the appropriate driver modules 512 for the requested modem task. For example, modems commonly provide both data and fax capabilities, and data modulations are

5 not needed for fax sessions. Thus, the scheduler 506 of the data pump loads only the driver modules 512 for data modulation during data modulation operations. Likewise, if the modem 404 is to operate as a speaker phone, the scheduler 506 will load only the speaker phone module into memory. Similarly, each modem task that can be performed with an individual driver module is typically implemented as one of the driver modules 512 and the scheduler
10 506 loads the required driver module(s) into memory of the computer exclusive of the other driver modules that are not required.

Figure 6 is a block diagram of exemplary self-contained signal processing tasks or driver modules that operate in conjunction with the software modem 404. As illustrated, the driver modules 600 could include at least the following drivers, a V.90 driver 602, a K56Flex
15 modem driver 604, a fax driver 606, a tone generator driver 608, a speaker phone driver 610, or other type of driver 612. The V.90 driver 602 represents the 56.0 kbps modem standard adopted by the modem Standards Committee. Similarly, the K56Flex modem driver 604 is a modem driver used by some modem manufacturers. Of course, the fax driver 606 represents a driver to be used for facsimile transmission, the tone generator driver 608 represents the
20 driver for producing modem tones during modem 404 operation, the speaker phone driver 610 provides speaker phone capability for the modem 404, and as represented by the dotted lines of the other type of driver 612, numerous additional types of driver modules can be included to operate the modem 404 with the scheduler 506.

The multiple driver software modem 404 provides a software data pump in which
25 each driver is a separate self contained object such as a driver, a data link library (DLL), a thread, etc. The scheduler 506 decides which driver should be loaded into computer memory, which driver should be activated, and what samples (if any) should be streamed to/from each

5 of the drivers to the hardware interface 410. Dividing these tasks into separate drivers provides for efficient usage of computer memory because drivers can be loaded into memory only as needed for each particular session and unloaded in accordance with the session progress.

Since different drivers are loosely coupled, whenever a driver is modified, the other
10 drivers that do not involve the modified driver do not need to be tested as would be required

in a single object data pump. In particular, fixing a bug in a driver only requires replacement of a single driver and the rest of the software modem remains unchanged. These advantages also apply in the development stage, e.g., a new driver may be replaced without modifying the rest of the modem and each driver can be more easily isolated and developed separately.

15 In operation, a typical modem task is a modulation, such as V.90, V.34, a tone detector, or any other task such as a pulse dialer. Individual modules are available for each of these tasks. Another module could be implemented in which all the hardware accesses are contained in a single module thereby providing an abstract interface to other modules.

The above-listed sections and included information are not exhaustive and are only
20 exemplary for computer systems. The particular sections and included information in a particular embodiment may depend upon the particular implementation and the included

devices and resources. Although a system and method according to the present invention has

been described in connection with the preferred embodiment, it is not intended to be limited to the specific form set forth herein, but on the contrary, it is intended to cover such

25 alternatives, modifications, and equivalents, as can be reasonably included within the spirit and scope of the invention as defined by the appended claims.

5

CLAIMS

1. A communication system comprising:

application software;

communication software that interacts with the application software;

communication hardware that interacts with the communication software;

10 the communication software including at least one controller and a plurality of objects, the communication software operating as an interface between the application software and the communication hardware such that the application software communicates with the communication hardware; and

the at least one controller enabling the application software to activate one or more

15 individual ones of the plurality of objects to provide communication between the communication system and a communication channel.

2. The communication system of claim 1 wherein the plurality of objects comprise driver modules having individual modem functionality.

3. The communication system of claim 1 wherein the at least one controller enables the
20 communication software to operate using a single one of the plurality of objects during operation of the communication system.

4. The communication system of claim 1 wherein the plurality of objects are individually modifiable and individually replaceable without regard to other ones of the plurality of objects.

25 5. The communication system of claim 1 wherein the plurality of objects are selected from the group consisting of drivers, data link libraries, and threads.

5 6. A method for operating a software modem on a computer system having a memory,
the method comprising:

creating a plurality of software modules that interact with one another to perform
software modem tasks on the computer system;

10 scheduling the plurality of software modem tasks according to specific operations of
the software modem;

loading individual software modules into the memory of the computer system on an as
needed basis as the software modem operates on the computer system; and

15 unloading individual software modules from the memory of the computer system
when the individual software module is no longer required for operation of the software
modem on the computer system.

7. The method of claim 6 further comprising modifying individual software modules
from the plurality of software modules, the modifications occurring independently of
remaining software modules in the plurality of software modules.

8. The method of claim 7 wherein the step of modifying individual software modules
20 comprises debugging the individual software module.

9. The method of claim 7 wherein the step of modifying individual software modules
comprises upgrading the individual software module.

10. The method of claim 7 wherein the step of modifying individual software modules
comprises isolating the individual software module to perform diagnostics on the software

25 modem independent of remaining software modules of the software modem.

5 11. A software modem comprising:

communication software and a modem card;

the communication software including a controller and a plurality of modules, the plurality of modules being independent from one another and operating according to instructions received from the controller such that only modules specified by the instructions
10 are executed in the software modem; and

the modem card including another controller, additional modules, and communication hardware, the another controller controlling which of the additional modules to activate for interaction with the communication hardware.

12. The software modem of claim 11 wherein the plurality of modules are modifiable
15 independently of one another and the controller.

13. The software modem of claim 12 wherein modules may be added to the plurality of modules already existing in the communication software of the software modem.

14. The software modem of claim 11 wherein the additional modules of the modem card are modifiable independently from one another and the another controller.

20 15. The software modem of claim 14 wherein modules may be added to the additional modules already existing in the modem card of the software modem.

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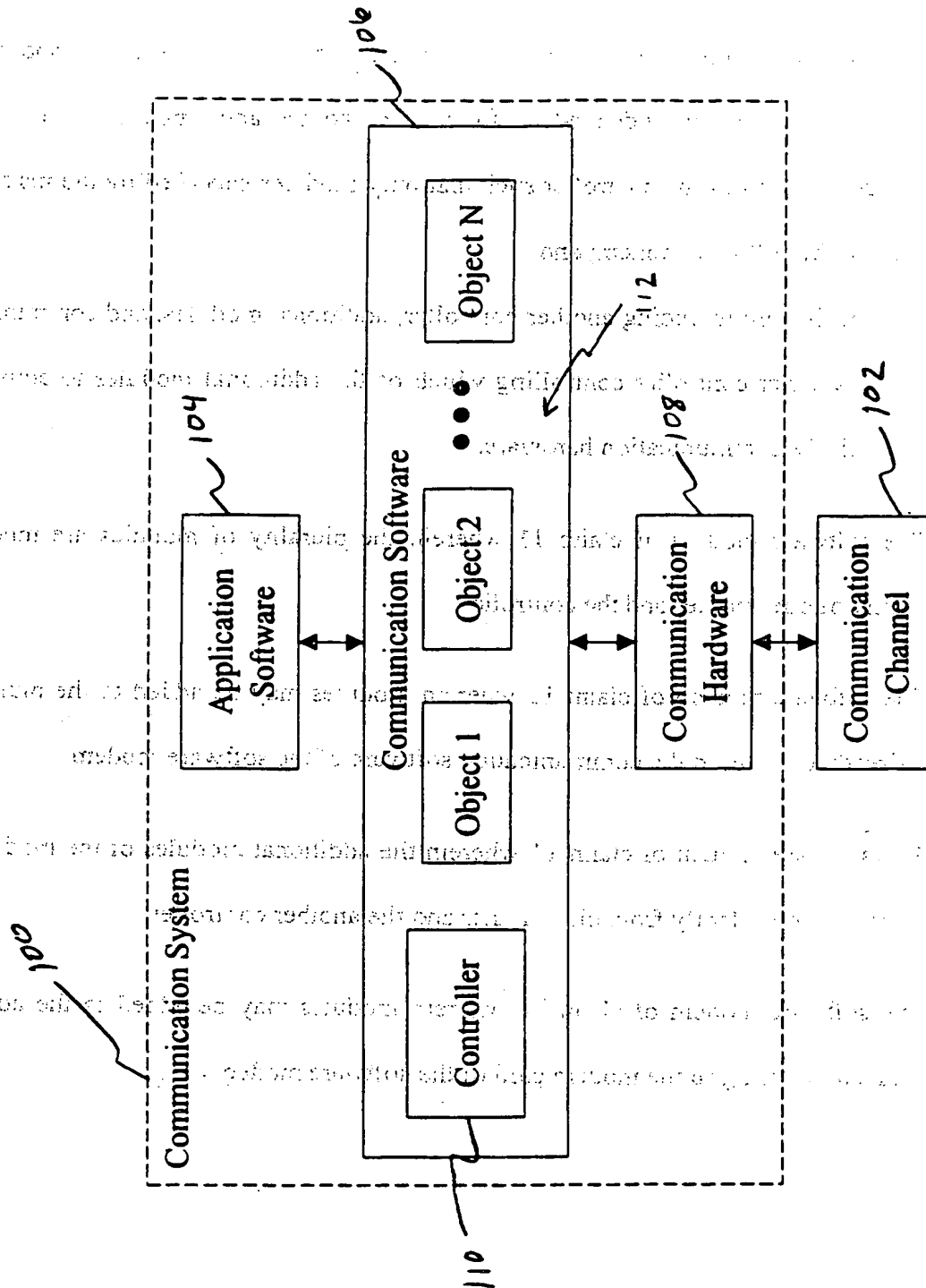


FIG. 1

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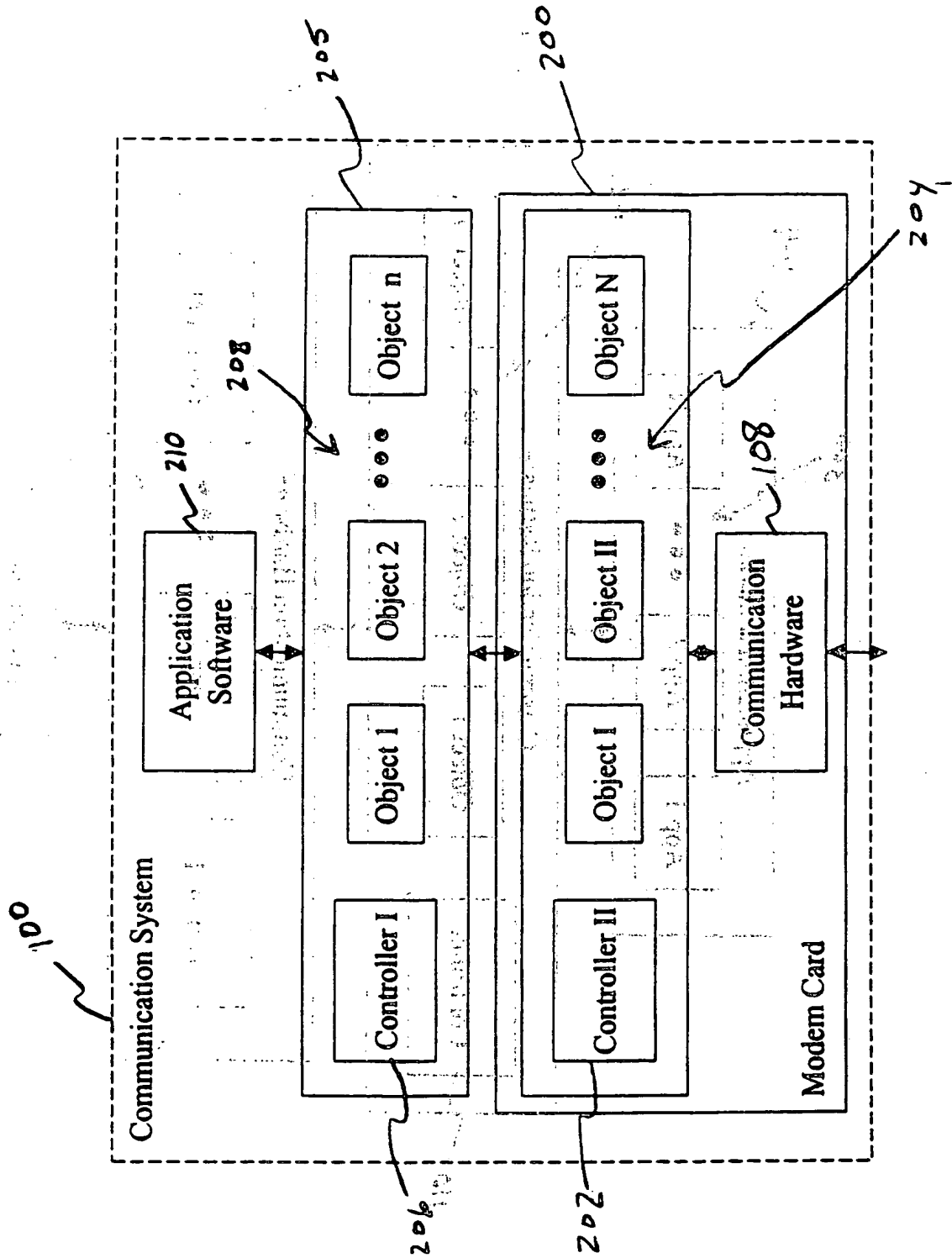


FIG. 2

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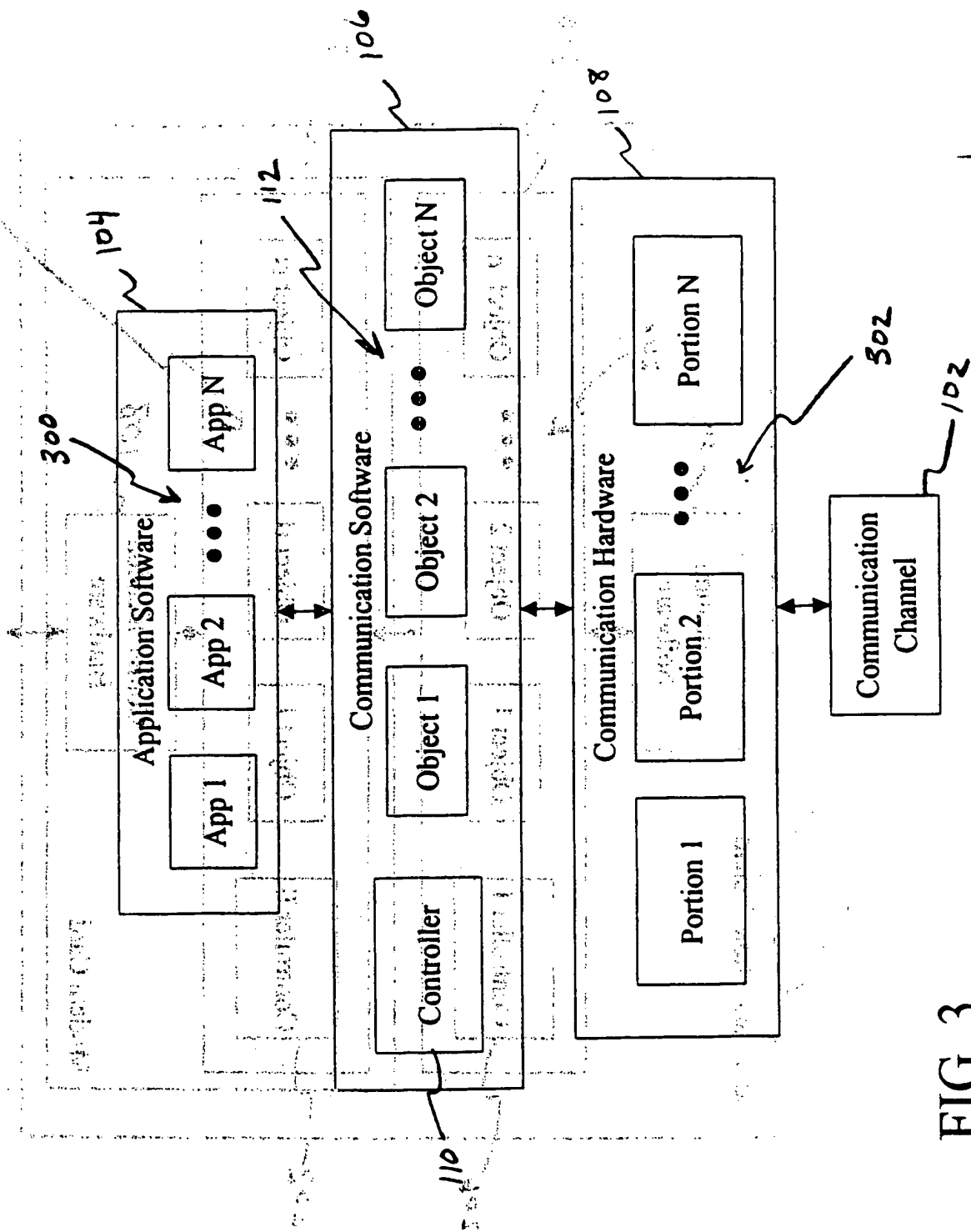


FIG. 3

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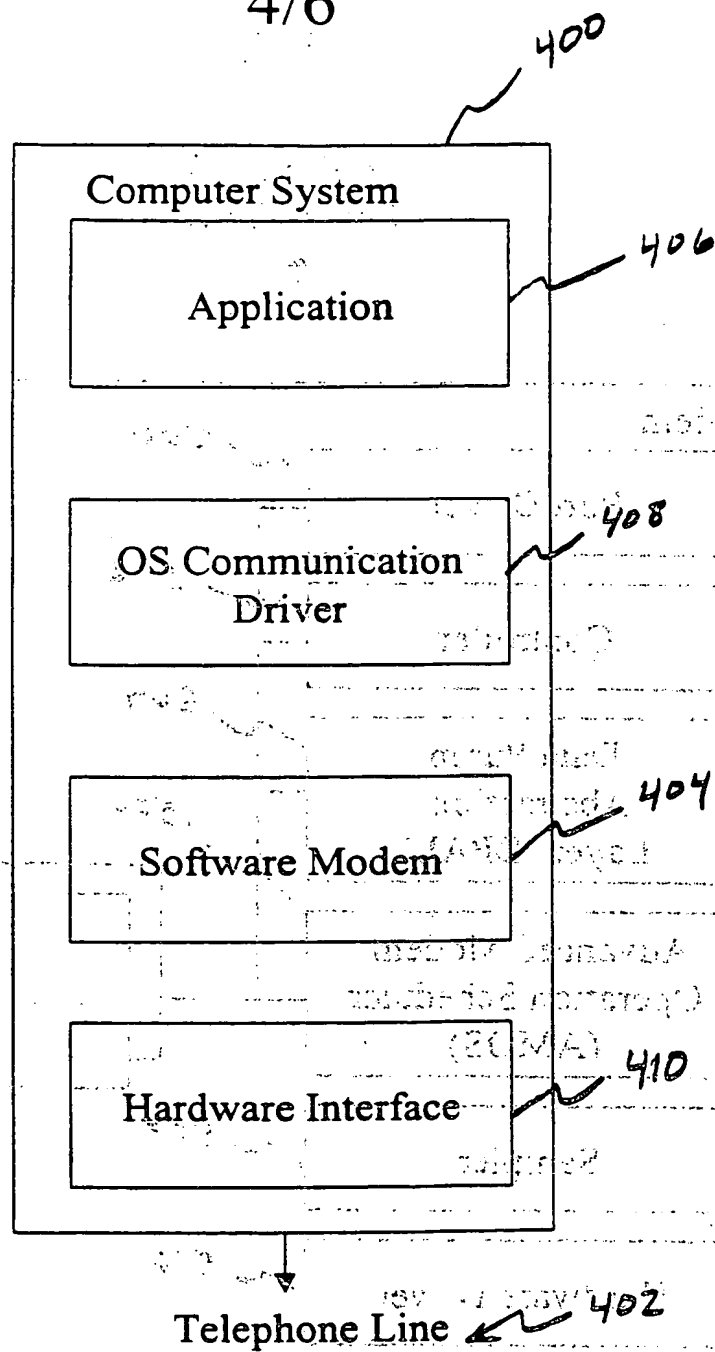


FIG. 4

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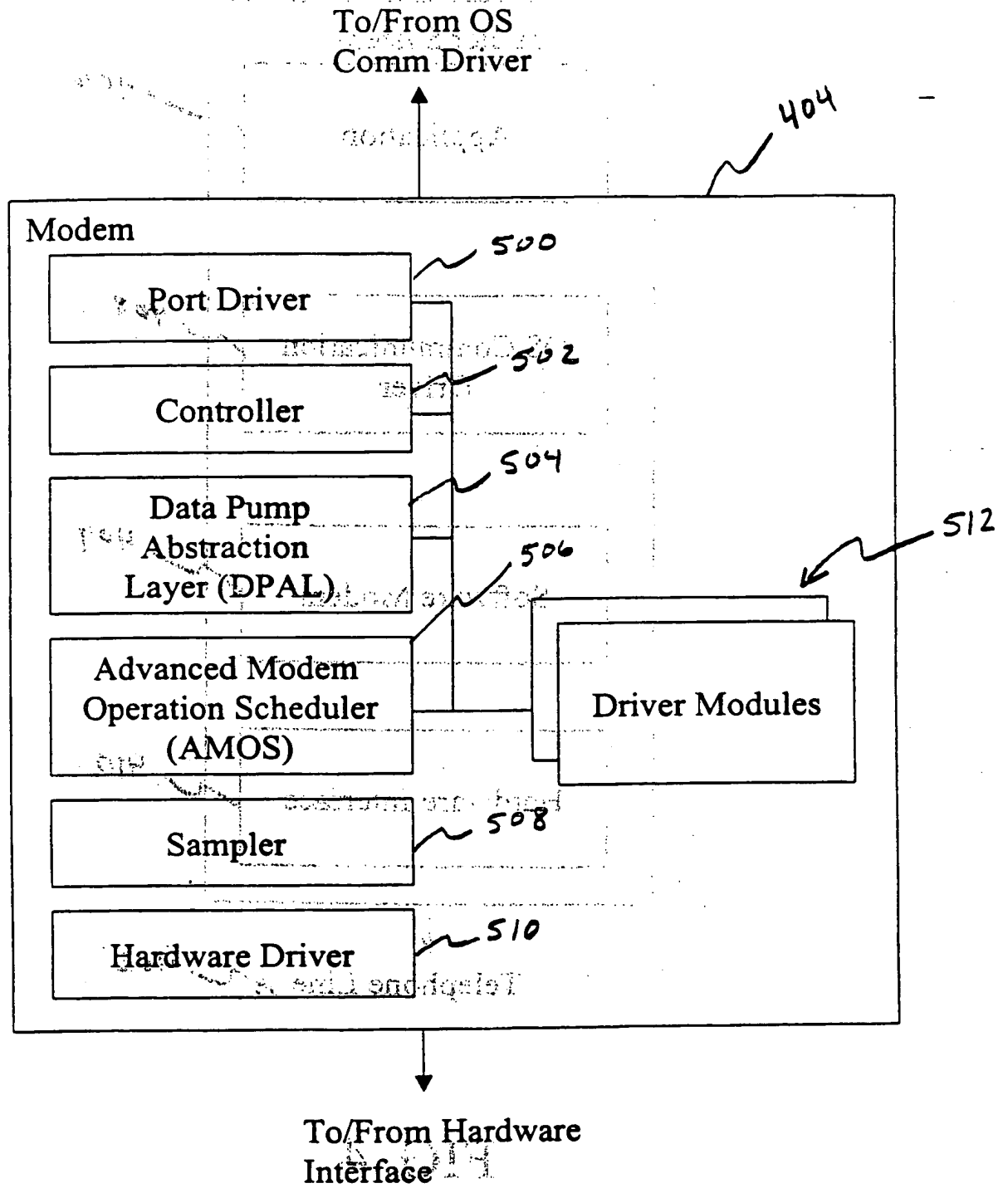


FIG. 5

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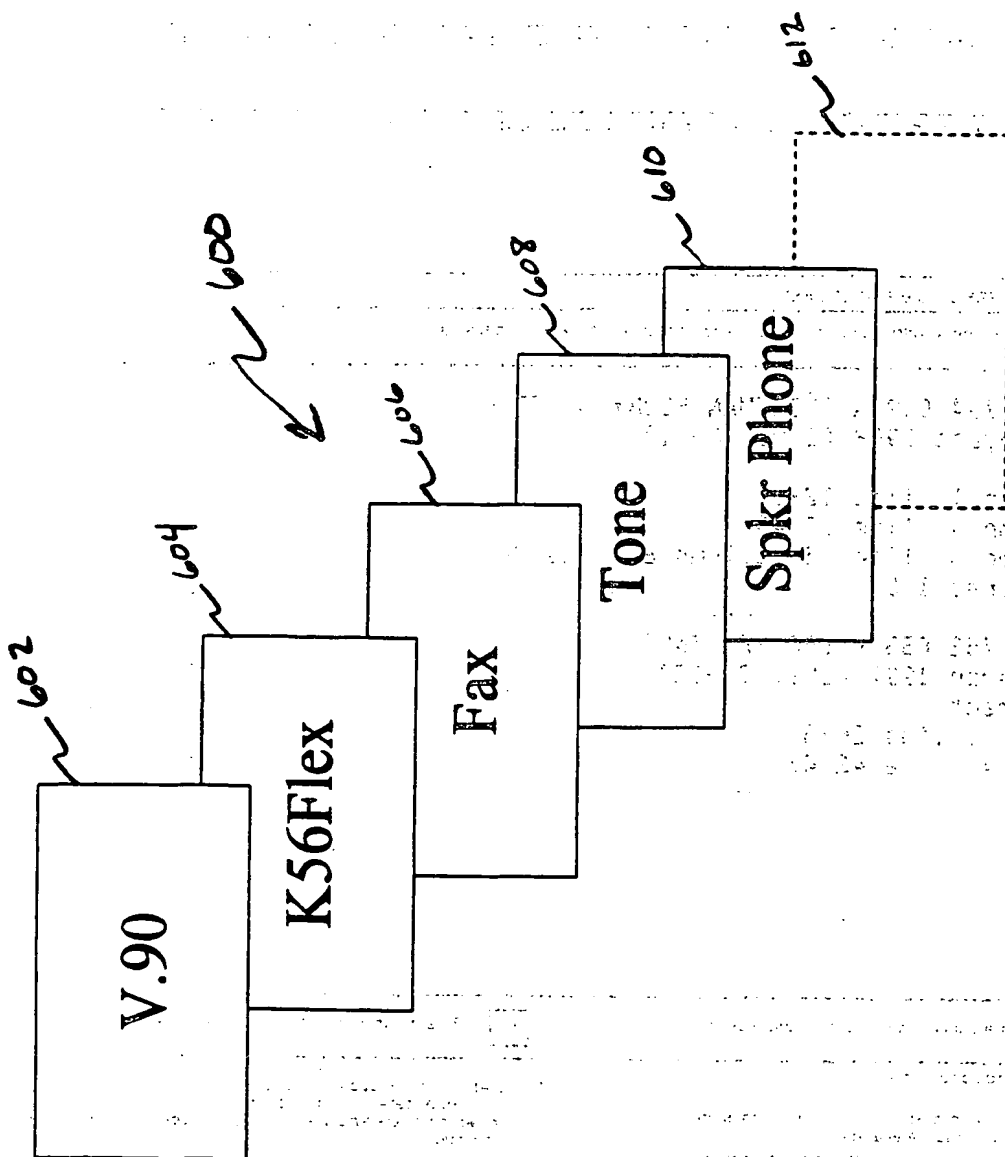


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/21660

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L29/06 H04M11/06 G06F9/445

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04M G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 794 009 A (COCEMAN ROBBY A ET AL) 11 August 1998 (1998-08-11)	1,3-5
Y		2
A	column 1, line 12-17 column 4, line 28-49 column 5, line 16 - column 8, line 20 figures 1,2	6,11
Y	EP 0 762 655 A (PC TEL INC) 12 March 1997 (1997-03-12)	2
A	abstract page 2, line 26-51 page 4, line 42-47	6,11

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

14 February 2000

Date of mailing of the international search report

25/02/2000

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INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 99/21660

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Information on patent family members

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